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An Evaluation of Crop and Land Use Data in a World Sample of Countries

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PREFACE

This publication deals with the adequacy of fundamental types of data on crop areas, crop production, crop yields, and land use in a world sample of 34 countries drawn from Asia, Oceania, Europe, North America, Central America, and South America. This information is needed as a guide to research and development now in progress in the science of remote sensing. It is likely that sensors can be developed which may provide useful data on crop areas, yield, production, and land use, as well as on many other aspects of agriculture.

Statements made about data collected in these countries are representative of a period approximately between 1960 and 1967. It is likely that changes may have occurred in some of the countries by the time analysis of data on them was completed. Further, as the need for basic data becomes more fully appreciated around the world, many countries whose data and data collection techniques are reported here as deficient will almost certainly show some improvement in the coming years.

The study was conducted by the Land Resources Branch, Natural Resource Economics Division, Economic Research Service (ERS), of the U.S. Department of Agriculture for the Earth Resource Survey Program, Space Applications Programs, National Aeronautics and Space Administration (NASA). This study is one segment of a larger one designed to provide guides for a long-range program of research and operations in the acquisition of data on agricultural and related resources by remote sensing methods through defining potential applications, assessing the relative importance of these applications, and specifying the requirements for data in each application area.

Information on the countries was provided by Mario Romero Guzman of the University of Costa Rica, the Foreign Regional Analysis Division of ERS, and Robert C. Otte, Percy R. Luney, Reed Hertford, Frederic A. Coffey, and Adlai F. Arnold, all of ERS. Selected sources of information used by these persons are listed at the end of this report.

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SUMMARY

The degree of necessity varies, but most countries of the sample could benefit from improved data on crop areas, yield, production, and land use. Present techniques used in this type of data collection do not appear to be adequate for the increasing need for information. Remote sensors, either aircraft- or satellite-borne, appear to have a role to play if sufficiently high standards of accuracy can be achieved and their costs of operation can be kept low. Such information systems offer the advantages of impartial reporting of data, coverage of large areas in short time periods, and a high frequency of coverage throughout the year.

The 34 countries were divided among five groups on the basis of the adequacy of their data collection. The majority of the countries were ranked in Groups III, IV, and V. Data collected in the countries of each of these groups are deficient in either accuracy, comprehensiveness, timeliness, or a combination of these. Group III consisted of India, Mexico, and New Zealand. Group IV consisted of Brazil, Chile, Costa Rica, El Salvador, Ecuador, Guatemala, Honduras, Kenya, Morocco, Nicaragua, Paraguay, Peru, South Africa, Syria, Thailand, Turkey, and Venezuela. Group V consisted of Nigeria, Sudan, and Togo.

The relatively inadequate data collection in these 23 countries is generally caused either by insufficient coverage of the agricultural areas of each country, poor techniques for data collection, small numbers of adequately trained personnel, or an inability or reluctance on the part of farmers to provide data. Another factor is a frequent lack of full appreciation by some governments of the need for obtaining such data and of its ultimate usefulness. In some countries where the need to respond to present or anticipated food problems is recognized, collection of data seems of minor importance compared to any program leading to a direct increase in production. On the other hand, in some of these countries, sufficient resources for the collection of more detailed or complete data probably cannot be spared. The resultant situation is one of a lack of the basic agricultural information necessary to make an accurate appraisal of yields, production, or areas devoted to various crops. Although this is the type of information required for planning and the orderly development which should follow, many of the countries in Groups III, IV, and V have embarked on more or less planned agricultural development without such data.

The countries in Groups I and II produce the most comprehensive, accurate, and timely data. Group I, consisting of Canada, the Netherlands, the United Kingdom, and the United States, produces the most useful. Group II consists of Australia, Denmark, East Germany, the United Arab Republic (Egypt), Romania, Spain, and Yugoslavia. The countries in these two groups are generally representative of the most highly developed agricultural countries of the sample. These are countries characterized by well-developed internal markets in agricultural commodities. They may also have active import-export trade in commodities. Even though area, yield, and production data collection is well developed, the nature of the economies of the countries in Group I is such that there is room for improvement in the speed at which data are collected. Some of the countries in Group II could benefit by more rapid or less cumbersome means of data collection.

Only a few of the countries in Groups I and II produce good land use data. Most countries in the entire sample have inadequate information about land use because such data are frequently only a byproduct of the collection of agricultural production data and as such omit large nonagricultural areas. Land use data in the economically more advanced countries are necessary for local and regional planning and for following changes over time. In the less developed countries, land use data and maps are tools to be used in national, regional, and local planning. They are also means of locating areas of potential agricultural development. Good land use data and maps are necessary in all cases where the pressure of population on agricultural resources dictates carefully planned decisions about the future use of the land.

AN EVALUATION OF CROP AND LAND USE DATA IN A WORLD SAMPLE OF COUNTRIES

by

Simon Baker*

INTRODUCTION

The main objective of this study was to provide information useful in determining how, and to what extent, remote sensing might help in supplying more accurate, comprehensive, and timely data on crop areas, crop yields, crop production, and land use around the world.

Remote sensing is the collection of data about the earth's surface by optical, electro-optical, and electronic devices--such as cameras, scanners, and radar--mounted in airplanes or satellites. It has received increasing attention, as techniques for sensing, recording, and transmitting information in and beyond the visible spectrum of light have been improved. There is still much to be done to make these techniques practical for collecting data on crops and land use. Whether efforts should be made to develop such applications, and if so, how aggressively, depends partly on estimates of the benefits they might bring.

Even countries with highly developed systems for collecting crop and land use data are interested in remote sensing. It promises to close some of the remaining gaps in available data, and to improve data quality and timeliness. Also, it may be possible, through remote sensing, to replace some present methods with less costly methods. To countries with less developed statistical programs, remote sensing offers a prospective means of acquiring the data they need, minimizing such obstacles as the scarcity of literate farmers and of qualified subordinate officials, the lack of cadastral records, and the competition of numerous development needs for scanty public revenues.

To fulfill the main objectives of this study, an inventory and evaluation of the agricultural and land use statistics of 34 countries, including the United States, were undertaken. Selected for study from among all of the continents where agriculture is practiced were:

1. Australia
2. Brazil
3. Canada
4. Chile
5. Costa Rica
6. Denmark
7. East Germany
8. El Salvador
9. Ecuador
10. Guatemala
11. Honduras
12. India
13. Kenya
14. Mexico
15. Morocco

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16. Netherlands
17. New Zealand
18. Nicaragua
19. Nigeria
20. Paraguay
21. Peru
22. Romania
23. South Africa
24. Spain
25. Sudan
26. Syria
27. Thailand
28. Togo
29. Turkey
30. United Arab Republic (Egypt)
31. United Kingdom
32. United States
33. Venezuela
34. Yugoslavia

For specific information about land use and the accuracy, comprehensiveness, and timeliness of the data on crop areas and yields in these countries, a variety of sources were consulted. Most of the country reports were provided by the Foreign Regional Analysis Division of the U.S. Department of Agriculture. The remaining reports came from other individuals both within and outside of the Department of Agriculture. A standard set of questions about area and yield statistics was devised to elicit facts about the accuracy, comprehensiveness, and timeliness of these statistics and to facilitate analysis and comparisons between countries. The land use information collected dealt mainly with statistics on unused but potentially productive lands in the sample of countries.

The content and completeness of the 34 country reports varied widely. There was a range in the reports from those in which all questions could be answered exactly to specifications to others based on limited available data and allowing only a few questions to be answered in a general way and not according to specifications. This situation appears to be close to the one found by the Food and Agriculture Organization of the United Nations in 1955, when they examined methods of collecting current agricultural statistics in 90 countries:

> "Existing agricultural statistics are still unsatisfactory because they vary from country to country in scope, concepts, accuracy, and coverage. Considerable improvement is needed if they are to serve more effectively such broad purposes as recording the trends of agricultural development, or measuring the progress of projects intended to increase production, or furnishing the sound basic data required by policy makers." 1/

Thus, it is nearly impossible to precisely evaluate and compare agricultural data collection in a sample of countries for two reasons: (1) Information about how and to what extent the data are collected is obscure, unpublished, or not available. (2) There exists a great variability in the methods, comprehensiveness, scope, and accuracy of data collection in the countries of the world.

1/ Narain, R. D. Methods of Collecting Current Agricultural Statistics. Food and Agriculture Organization of the United Nations, Rome, 1955, p. 1.

Grouping of Countries

Since the kind and extent of data deficiencies are different from country to country, and the kind and extent of potential benefits from remote sensing also vary, it might seem to have been logical to evaluate the countries individually. It was decided, however, to consider the countries by groups, for several reasons. First, it was not possible within the time and resources available to obtain completely satisfactory information about the statistical programs of the countries studied. Second, even if it had been desired, the criteria did not permit a completely objective comparison or rating of any two countries. By grouping countries it was possible to evaluate the different levels of adequacy in groups that are relatively homogeneous as regards their agricultural statistics. This method supported the basic intent of the study, which was to look at the world data situation and identify typical world data problems. The study was not concerned with comparing individual countries; the fact that countries were found to fall into groups with typical data problems should serve only to facilitate the identification of gaps in data collection with regard to type and degree of problems, and to determine what type of problems might be aided by remote sensing.

Five categories of countries were set up according to the following criteria:

Group I. Countries with a high degree of accurate, comprehensive, and timely data and efficient collection organization. Although not perfect, these organizations function smoothly and major improvements would be difficult or extremely costly.

Group II. Countries with good data collection organizations doing adequate but not intensive jobs. Data are accurate and comprehensive but may not attain an equally high standard for timeliness. Dissemination of data may not be widespread.

Group III. Countries making a consistent effort to collect accurate data, but having problems with comprehensiveness. Timeliness may also be deficient.

Group IV. Countries with developing organizations for data collection. Accuracy, comprehensiveness, and timeliness may be lacking.

Group V. Countries which collect a minimum of data and whose organizations for this purpose are rudimentary. These countries have the least knowledge of the quantitative and locational aspects of their agriculture.

The countries of the sample were classified as follows:

Group I.	Canada	United Kingdom	
	Netherlands	United States	
Group II.	Australia	Romania	Yugoslavia
	Denmark	Spain	
	East Germany	United Arab Republic (Egypt)	
Group III.	India	Mexico	New Zealand
Group IV.	Brazil	Honduras	South Africa
	Chile	Kenya	Syria
	Costa Rica	Morocco	Thailand
	El Salvador	Nicaragua	Turkey
	Ecuador	Paraguay	Venezuela
	Guatemala	Peru	
Group V.	Nigeria	Sudan	Togo

A classification system of five categories was selected because the nature of the country reports did not warrant a more detailed breakdown. On the other hand, fewer than five categories would have made for rather coarse distinctions between groups. This decision, admittedly subjective, was carried out only after careful consideration of the nature of the information at hand and the objectives of the study. As a consequence of this classification, the countries found in any one group represent a wide range of conditions. The actual ranking of the countries from Group I to Group V was also largely subjective because of the unevenness of the data provided in the country reports and the lack of a precise basis for evaluation in many cases. The author does feel, however, that the countries of any given group fall within the stated range of criteria.

Definition of Terms

To convey more fully the distinctions between the groups and to illustrate the variations and similarities of countries within each one, each group is discussed separately. The terms "accuracy" and "comprehensiveness" appear throughout, as does discussion of timeliness of the release of data. With reference to area data, the terms have the following meanings:

Accuracy. Appraisal of procedures used in obtaining and processing data on areas devoted to various crops.

Comprehensiveness. Examination of the portion of the total area of a country covered and of the extent of completeness of coverage within that area by the survey or census organization.

Timeliness. Appraisal of the time of release of statistics by a government; release is considered prompt (or timely) if it normally occurs within 1 month of the peak of harvest for "harvest data" or within 1 year for "revised harvest data."

With reference to yield and production data, the terms have the following meanings:

Accuracy: Evaluation of the data itself based on the methods for gathering and processing it.

Comprehensiveness. Appraisal of the completeness of crop enumeration in relation to the means by which data are obtained.

Timeliness. Appraisal of time of release of the data; the estimates released by a government are considered prompt for "forecast" if they are made prior to the harvest and are based on evidence not more than 1 month old; they are prompt for "harvest" if they are made within 3 months after the close of the harvest.

GROUP I

Crop Area

At the very least, each of the countries in Group I--Canada, the Netherlands, the United Kingdom, and the United States--collects data on areas planted annually for the entire country, except for the exclusion of Newfoundland in the case of Canada. All four countries depend on questionnaires filled out by farmers. The United Kingdom and the Netherlands conduct complete annual enumerations of their farmers to obtain this information, while the United States and Canada each take an annual sample of farms. In addition, the United States collects information on intentions, forecasts during the growing seasons, and areas harvested. The United Kingdom also makes forecasts throughout the growing season. Accuracy of these data in all four countries is good and release of the information is timely.

The reliance of the four countries on the use of questionnaires filled out by farmers is facilitated by the high level of literacy of their agricultural populations. A progressive and prospering agriculture is frequently associated with a high level of literacy in many countries of the world. Further, the reliance of these four governments on the words of their farmers and the willingness of the farmers to honestly declare the required information is indicative of the atmosphere of mutual trust and cooperation which exists.

Yield and Production

All countries in this group use an eclectic system for gathering information about yield and production. They may use information provided by the farmers themselves, crop reporters, local government officials, and commercial sources. The combination of good area statistics with complete production data produces accurate yield statistics. In all four countries, yield and production statistics are promptly reported. In all the countries but Canada, forecasts are made of yields.

Land Use

Both the Netherlands and the United Kingdom have complete information in the form of maps, in addition to tabular data, about how their lands are used. The circumstance of small area with high population density and a resultant high value of agricultural land has caused concern in both countries that their limited land resources be used to the best advantage. Their up-to-date land use maps provide information about present conditions and also are basic sources of information for use in planning. In the 1930's, the British conducted their first national land use survey in which results were presented in map form. This information proved to be of great value during World War II, when there were extreme pressures on the agricultural capabilities of the United Kingdom. In the postwar period, another land use survey was conducted to meet the needs of a changed situation.

Canada is now mapping its land use and converting this information for computer processing. The land use mapping is considered to be an essential part of the larger Canada Land Inventory being conducted by the Agricultural Rehabilitation and Development Act Administration.

> "The broad objective of the Canada Land Inventory is to classify lands as to their use capabilities, and to obtain a firm estimate of the extent and location of each land class. These lands would be classified according to:
>
> --Their physical capability for use in agriculture, forestry, recreation, and wildlife management;
>
> --their present use;
>
> --socio-economic factors relative to their present use.
>
> "This vast amount of information on Canada's land resources is to be gathered, stored, analyzed, and published in such a way that the inventory will become a working tool in the rural development program across Canada." 2/

2/ The Canada Land Inventory: Objectives, Scope, and Organization, Report No. 1. Department of Forestry Publication No. 1088, Ottawa, 1965, p. 5.

Of the countries in Group I, the United States has the least satisfactory land use information.

> "By and large, land use data for the United States are a hodge-podge. It is very difficult to obtain national total acreages for many land uses on a consistent and meaningful definition. Several useful publications, notably those by the Economic Research Service of the United States Department of Agriculture, have summarized and brought into reasonable comparison such data as do exist. But the authors of these studies are fully aware of the deficiencies of the data they use. Moreover, the situation is much worse if one attempts the same data compilation and summarization on a regional, State, or smaller geographic basis. Errors which average out or are concealed in national totals may become glaring for smaller areas." 3/

A generalized breakdown of land use in all 34 countries of this sample as well as all the other countries of the world appears in the annual Production Yearbooks published by the Food and Agriculture Organization. Seven classes of land use information are listed:

1. Total area
2. Land area
3. Arable land and land under permanent crops
4. Permanent meadows and pastures
5. Forested land
6. Unused but potentially productive lands
7. Built-on areas, wasteland, and other

The data collected on "unused but potentially productive lands" in the sample countries will be discussed later in this paper.

Land use information for the Netherlands and the United Kingdom is also available according to the classification system of the International Geographical Union (I.G.U.). 4/ (A number of other countries in the sample have also been classified according to this scheme and will be so designated in the following text.) In the I.G.U. system, land use is broken down into nine classes:

3/ Clawson, Marion, with Charles L. Stewart. Land Use Information, A Critical Survey of U.S. Statistics Including Possibilities for Greater Uniformity. Resources for the Future, Inc., Washington, D C., 1965, p. vii.

4/ Van Valkenburg, S. "The World Land Use Survey," Economic Geography, Vol. 26, Jan. 1950, pp. 1-5.

1. Settlements and associated nonagricultural lands
2. Horticulture
3. Perennial crops
4. Cropland
5. Improved grassland
6. Unimproved grazing
7. Forest
8. Swamps and marshes
9. Unproductive

This classification system will also be discussed at a later point in this paper.

GROUP II

Crop Area

The countries in Group II are Australia, Denmark, East Germany, Romania, Spain, the United Arab Republic (Egypt), and Yugoslavia. The completeness of coverage of the agricultural areas in these countries is on a par with that of Group I. The accuracy of crop area data is good for Yugoslavia, Australia, and Denmark. Spain's data on areas of wheat, rice, sugar beets, hops, tobacco, cotton, olives, and citrus are good, while the information on all other crops is fair. The United Arab Republic is another country in which the accuracy varies. Special efforts, in the form of measurements made on the ground, are carried out on the cotton, rice, and wheat crops. This is the so-called objective method, and it results in good accuracy for those crops. The remainder of the crops are covered by reports obtained from farmers and the data are of doubtful accuracy. Romania and East Germany produce fairly accurate crop area statistics.

The publication of crop area data is prompt in Australia, Spain, and Denmark. The UAR, Yugoslavia, Romania, and East Germany are usually late in their publication of data on areas planted and harvested. However, the data are most likely available on time for internal use within these governments.

Yield and Production

Only Yugoslavia, Romania, Spain, and Denmark make forecasts of their expected production during the crop year, but all countries in this group collect data on production after the harvest has been completed. The methods used to obtain such information vary a great deal. In Yugoslavia and Romania, the socialized farms are required to keep records of their activities, and these

form the basis for production estimates. The details for East Germany are not known, but it is assumed that the socialized farms of this country follow the same pattern. There are also a number of private farms in Yugoslavia, and government crop reporters make production estimates for them. Spain obtains production information from a variety of sources, including agricultural syndicates, agricultural cooperatives, and various other farm organizations. Australia relies on an annual census of farmers in which the schedules or forms are filled in by the individual farmers. A sample enumeration of all farms is carried out in Denmark, and its results are expanded to arrive at the national estimates. The UAR also uses a sample survey covering most of its production. Information about the production of the major export crops--cotton, rice, and onions--is obtained from government sources which record trade in these commodities.

The accuracy of yield and production statistics for the countries in this group is generally fair. Denmark and Spain are above this general level. East Germany is thought to be average, despite the lack of information which would make a check of accuracy possible. Australia's production data are fair, but yield information is poor because the acreages actually harvested, as opposed to the amounts planted, are not known. Students of UAR statistics point out an upward bias in production and yield data when a harvest is first reported. These same data, when published later, are usually revised downward to a level more indicative of the actual situation.

Publication of data in Yugoslavia, Romania, and East Germany is late, but, as indicated above, the data are gathered and made available to the agencies of the various governments long before they are made public. UAR data on yield and production are late for two reasons: (1) There is a time lag between the end of the harvest and the final summarization of the data, and (2) there is a government policy of withholding such information until well after the crops have been marketed or otherwise disposed of. Publication of data by Spain, Australia, and Denmark is timely.

Land Use

Data are available for the entire land areas of Yugoslavia, Romania, East Germany, Spain, and Denmark according to the classification system established by the International Geographical Union. No I.G.U. data are available for the UAR and Australia. For the UAR, only the details of land use within the cultivated portion of the country are known. The noncultivated areas are either sparsely inhabited or totally uninhabited. Thus, the information which is collected gives a nearly complete picture of land use in the important parts of the country. Australia has very poor land use statistics for about 40 percent of its total land surface. This is the part of the country which is mostly undeveloped and lies outside of the main farming areas. The remaining 60 percent of the total area is classified as being in farms, and the annual agricultural statistics provide the basis for knowledge of land use in this area. The situation is roughly analogous to that of the UAR.

GROUP III

Crop Area

Crop area data for the countries in this group--India, Mexico, and New Zealand--suffer from incomplete coverage. These countries do have in common the fact that each is making a consistent effort, but one not yet of high enough quality to permit the country to be classified in Group II. In addition to crop area data, this is true of the other agricultural information collected.

In the post-independence period, India has come to rely on sample survey methods to determine the areas of crops planted each season. This technique is used because the area of the country is so large and the number of qualified statistical workers is so small. Due to the high rate of illiteracy and the traditional distrust of officials whose purposes farmers fear might bear some relation to taxation, reliance cannot be placed on mailed questionnaires or interviews with farmers. The sample survey technique has been found to produce complete coverage for the major crops, and accuracy for these crops is good. However, coverage for minor crops is incomplete, and thus accuracy is poor.

In contrast to India, New Zealand determines its harvested areas annually by a postal census of farmers. The accuracy of data obtained by this method is good; however, the information is collected only for holdings of 10 or more acres. In addition, a survey of farmers is made each spring to produce a forecast of intentions to sow wheat, oats, barley, peas, corn, and potatoes. The accuracy of this survey is also good.

In Mexico, coverage is incomplete. Annual data are collected for only 40 percent of all the farms because of the omission of the small farms and ejidos, or farms on public land. There is an unevenness in information about areas devoted to various crops. The most important crops, either for export or internal commercial purposes, tend to receive the most attention. Subsistence and other minor crops tend to be neglected at present. Because of this situation, the accuracy of area information ranges from good to poor.

The publication of data on area of crops in India and Mexico tends to be late. In New Zealand, release of data is prompt for the grain crops, but late for all others.

Yield and Production

In all the countries in this group, coverage of crops is incomplete. Yield and production data are obtained mainly for the crops considered important. These are either the major crops, as in the cases of India and New Zealand, or the crops that enter commercial channels at home or international markets, as is the case in Mexico. The data are good for the major crops grown in India and New Zealand. In Mexico, the production of the important crops appears to be regularly overstated in the annual data. For the less important crops, production is seriously overstated.

The release of data after harvest is prompt in India, but late in New Zealand and Mexico.

Land Use

Information about the use of the total land areas of the countries in this group is lacking in each case. India is most complete, with 92 percent of its area accounted for in 1962/63. Mexico has land use data on about 75 percent of its area. The basis of this information is the census, which covers mainly the agricultural areas. A similar situation exists in New Zealand, where about 66 percent of the country is covered by land use statistics. They are derived from the census of agriculture taken for farms in the agricultural areas and only for holdings of more than 10 acres. In each country, the emphasis is on the agricultural areas, and the urban and nonagricultural segments are not as well documented.

GROUP IV

Crop Area

The countries in Group IV are: Brazil, Chile, Costa Rica, El Salvador, Ecuador, Guatemala, Honduras, Kenya, Morocco, Nicaragua, Paraguay, Peru, South Africa, Syria, Thailand, Turkey, and Venezuela. Data on the crop areas of these countries are generally poor. The chief reason is incomplete coverage, which may be due to one or a combination of the following factors:

1. Subsistence or noncommercial crops are overlooked and not reported. A number of countries make their best data collections for important export or commercial crops and make only a fair or poor effort for all other crops.

2. A large part of the country may be left out of any measurements which are made. In South Africa, the European farms are covered and the Bantu farms are not. Peru covers only the central coastal area in its enumeration.

3. Farms or holdings below a certain size are not included in the national enumeration. In countries practicing traditional agriculture, many farms are very small and thus may be left out. Holdings under 0.32 hectare are excluded in Thailand; Costa Rica does not include farms of under 0.7 hectare. In Guatemala, farms of under 4.28 hectares are not included in the regular enumeration, but are sampled on a nonprobability basis. Holdings of less than 0.7 hectare are not covered in Nicaragua. Chile excludes farms of less than 1 hectare, and Peru does not enumerate holdings of less than 10 hectares in its central coast area.

4. Small or remote areas may be left out, as in Syria, where coverage is partial for all crops, or in Turkey and Costa Rica, where small, fragmented parcels of land may be excluded.

5. Estimates are made by local officials without special statistical training and are based on subjective judgment rather than on accurate measurement. Understandably, even the most conscientious local official, given the numerous and irregularly shaped small fields found in many of the countries of this group, would find it impossible to make correct estimates by this method. Some countries attempt to cover their entire agricultural areas but lack sound information because of such reliance on local officials. Other countries use local officials and have only a partial coverage of their agricultural areas.

6. Areas planted may be deliberately underestimated as a way of avoiding or alleviating governmental taxation or control of the crop.

At the heart of the problem of incomplete coverage and resultant poor data is the general lack of cadastral surveys or even reasonable approximations of agricultural land areas in the form of large-scale maps. Even if such surveys or maps do exist, they may not cover the subsistence sector of a country's agriculture. In tropical countries where shifting agriculture is practiced, even maps and surveys would be of little assistance in locating and measuring this type of agriculture. The sizes of individual fields then becomes a matter of opinion, with the farmer and the statistician not necessarily in agreement. Since regional and national data on areas devoted to agriculture are ultimately based on summations of individual fields, it is clear why such data are deficient.

The accuracy of general crop area data in Chile and Nicaragua is fair. In many other countries in this group, the accuracy may be fair to good for certain crops, but poor for the remaining ones. This is the result of the situation described above under heading No. 1, where the emphasis is on commercial crops and accuracy is poor for subsistence or noncommercial crops. The following countries, in varying degrees, fall into this category: Kenya, Morocco, South Africa, Syria, Turkey, Costa Rica, Guatemala, Honduras, El Salvador, Paraguay, Ecuador, and Peru. For the remaining countries in Group IV (Brazil, Thailand, and Venezuela), accuracy is generally poor.

Only two countries in Group IV issue their crop area data promptly after collection; these are Turkey and Thailand. Several other countries promptly issue area statistics on one or more of their important commercial crops but are usually late in reporting on their other crops. The remainder are uniformly late.

Yield and Production

Data on crop yield among the countries in Group IV are generally poor. Yield surveys, as such, are rare in this group. The alternative way to determine yields is to know both the acreage devoted to a crop and the crop's total production. From these two items, it is possible to calculate the yield per unit of area. The countries in this group suffer from a lack of accurate information about the crop areas harvested. Many of them are also deficient in accurate production data. The lack of one or the other of these kinds of data

is enough to prevent the calculation of reasonably accurate yield statistics. All of the countries in this group, then, are lacking in reliable nationwide yield statistics for all but a few important export or commercial crops.

Better data are available for production than for yield. This information may vary from approximations of production, as in Kenya, through dubious data obtained by eye estimates, as is the case in several countries, to reasonably good statistics for commercial and export crops in South Africa, Turkey, Costa Rica, Honduras, and some other countries. On the whole, however, the countries in Group IV lack good production as well as good yield statistics. The inaccuracy of both kinds of data is directly related to the incomplete crop coverage and the methods employed to measure production.

Data on production of crops are gathered in a variety of ways and individual countries may utilize several methods. An example of this is the use of eye estimates together with marketing information. The eye estimate is employed in making subjective judgments of production at harvest time. It is usually carried out by a local official who may or may not be connected with the nation's statistical organization. Such estimates are usually made for the food crops which are of local importance and are not grown for export. For the commercial or export crops, the government in question may resort to its own customs data or to the reports of producers' organizations or marketing organizations. Countries which obtain their crop data in this combined fashion are Morocco, South Africa, Syria, Turkey, Guatemala, Paraguay, Ecuador, Peru, and Honduras.

Costa Rica and El Salvador rely on a combination of marketing data for their commercial and export crops and sample surveys for their other crops. In Costa Rica, an eye estimate is also used in the case of coffee production.

Eye estimates of production for all crops, mainly by local officials, is prevalent in Venezuela, Nicaragua, Chile, Thailand, and Brazil. Chile also uses professional statistical personnel to make a sample check of farms. In Brazil there is a lack of confidence in the eye estimates of crop production which are the basis for the statistics issued by the national government. This has led several semiautonomous Federal agencies to collect their own statistics for coffee, sugar, rice, and cacao. The States of São Paulo and Minas Gerais do the same for crops produced in their areas.

Kenya relies heavily on marketing data to determine production. The government assumes that nonfood crops purchased by marketing boards or delivered to processing plants are equal to the total production of those crops. Statistics on food crops are obtained from marketing sources and do not give a true indication of national production. This is so because most of the food grown by the African farmers in Kenya is consumed for subsistence without passing through the normal marketing channels. Thus, the government does not measure the production of food in the country but only makes approximations. The exception is wheat, which is mostly grown in the so-called Scheduled Area and can be measured.

The reporting of yield and production data is prompt for all crops in only three countries of this group: Turkey, Thailand, and Chile. Several

countries report on some of their crops promptly but are late for the remainder. South Africa, Syria, Costa Rica, Honduras, and Ecuador report promptly on important commercial or export crops. The remaining countries in Group IV are generally late in their reports of yield and production for all crops.

Land Use

A complete accounting of land use for the total area of a country in this group is the exception rather than the rule. Only Thailand, Turkey, and Syria have data on their total areas. Turkey is exceptional in that its land use statistics lend themselves to arrangement under the classification system of the International Geographical Union.

Even though its entire area is not accounted for, Chile probably has the highest quality of land use data of any country in Group IV. This is due to the detailed study conducted by the Aerophotogrammetric Project in 1960 which resulted in the land use mapping of 15 percent of the area of Chile. Despite the limited coverage, some 90 percent of the value of all agricultural lands was included in the small area mapped. Aerial photography and field work were utilized to rapidly produce the highly accurate maps, which are outstanding compared with the information on land use available for the other countries of Group IV. 5/

Most of the countries in this group at least have information about land use on portions of their land areas. The area covered may vary from as little as 12 percent in Ecuador to as much as 75 percent in El Salvador. The main source of information for each of these countries is their most recent agricultural census. Frequently, however, the census may be years out of date or the most recent census data may not yet have been prepared for publication. Further, each census is concerned with the major area in farms and how it is used. This leaves a large part of each country unaccounted for. The area outside the scope of a census may also contain some scattered farms, but they are not enumerated. This is especially true in the tropics under conditions of shifting cultivation or of farming in isolated areas. The nature of the nonfarming areas outside of the scope of the census is usually known in a very general way only. Lands available for potential development are usually to be found here, and their nature and extent can only be guessed. Finally, census data may constitute a very poor basis for the making of anything but the most general type of land use map. This is a disability in any development effort.

GROUP V

Crop Area

The countries in this group--Nigeria, Sudan, and Togo--are placed here because their agricultural data collection is least adequate or because little

5/ Vera, Luis, Agricultural Land Inventory Techniques--Experience of the OAS/Chile Aerophotogrammetric Project, Technical Manuals, II, Pan American Union, Washington, D.C., 1964, pp. 62-70.

information was obtainable on their procedures. In Sudan, data are obtained on 85 to 90 percent of the area planted in cotton, but only 25 to 30 percent of the areas devoted to all other crops are measured. Nigeria has large areas in shifting cultivation or in mixed cropping with a number of different crops planted in the same field. These conditions present problems which even countries with excellent statistical organizations would have difficulty solving. Information available about crop area in Togo is limited. Areas devoted to all crops are estimated, but no information was available about the nature of this estimate or the means by which it is carried out.

As in all the countries, accuracy in crop area data for this group is closely tied to the completeness and means of coverage employed in obtaining the data. In Sudan, crop area data on cotton are accurate, but because coverage is limited on other crops, the area data on them are poor. Under the conditions in Nigeria described above, acreage of crops reported in that country must be considered completely inaccurate. The accuracy of crop area data in Togo is fair.

Sudan reports its cotton data promptly but is late for other crops. The degree of timeliness of reporting crop areas in Nigeria and Togo is not known.

Yield and Production

Since most cotton grown in Sudan is run through gins there, it is possible to obtain production figures. Yields are based on this production data and the estimates of areas planted to cotton. For all other crops, eye estimates of production are made and these are combined with eye estimates of acreage to calculate yields.

In Nigeria, production and yield data are almost completely lacking. Togo is reported to have conducted a census in 1961/62, but there is insufficient information available about how it was conducted or how comprehensive it was.

There is no basis on which to judge the accuracy of crop yield and production data in the three countries of this group. Accuracy in all cases is subject to question because of the methods used to obtain basic data.

Sudan is timely in reporting yield and production of cotton but is late for all other crops. Nothing is known about the timeliness of reporting in Nigeria and Togo.

Land Use

Of the countries in this group, Sudan has the best information available on land use. This is not the result of a regular government program for the collection of such information but is due to the efforts of one man. J. H. G. Lebon has analyzed and mapped the various types of land use in Sudan according to the classification of the International Geographical Union. This is the best and most complete source of land use data for that country. 6/

6/ Lebon, J. H. G. "The Land Use Survey of Sudan: Some Problems of Classification and Mapping," Land Use in Semiarid Mediterranean Climates. UNESCO/ International Geographical Union Symposium, Iraklion, Greece, Sept. 1962, pp. 139-149.

Any land use data on Nigeria are, at best, only rough approximations. Some information exists for Togo, but its accuracy and the basis for its collection are not known.

CONCLUSIONS

Of the 34 countries in this worldwide sample, 23 were found to be deficient in varying degrees in either the accuracy, comprehensiveness, or timeliness of their agricultural data. Of these 23 countries, those in Group III have problems mainly involving comprehensiveness of data, while those in Group IV produce data that are deficient in accuracy, comprehensiveness, and timeliness. Agricultural data collection in the countries of Group V is in the rudimentary stage. Most of these countries may be described as underdeveloped or developing. Many of them are under growing pressure to produce more food for larger and larger populations. The need for action is felt in varying degrees among them. One kind of action that has gained wide acceptance among developing countries is planning, or more specifically, national development planning.

Before a reasonable plan can be conceived, countries must know and understand conditions as they really are. Where agriculture is involved it is necessary to know yields and production of crops as well as their locations and the area devoted to them. Many other kinds of agricultural data are also necessary, but the above are the basic types of information required.

Also needed at early stages in planning is information on the current and potential use of land over the whole surface of the country or region to be developed. Such data should include details on the kinds of agriculture being practiced and the extent of areas devoted to the various crops. This information collected at intervals over a period of time is desirable and represents valuable historic land use information.

Because crop area, yield, and production data in the countries of Groups III, IV, and V are of insufficient quality, many countries do not know the true extent of their food problems. Nor can they have the adequate basis for good planning that is outlined above. Given good crop yield and production data, it becomes possible to locate the high and low production areas within a country and to efficiently direct the agricultural improvement of areas that are currently producing. For many developing countries, the upgrading and improvement of traditional agriculture is of as great or greater priority than the development of new lands.

The improvement of data collection using currently recognized techniques is very slow and, in some instances, an extremely difficult process. There is need for a system of rapid collection of correct and impartial reporting on crop areas, yield, and production. Such a system should ideally cover an entire country in a matter of days and should be able to do so several times throughout the growing season. In this way, the amounts and conditions of the crops planted and like information about the crops to be harvested could be obtained. This would provide the additional benefit of timely information on crop failure and possible famine. Only remote sensors in aircraft or satellites may be able to accomplish these tasks according to the above specifications.

In the agriculturally more advanced countries of Groups I and II, the rapid collection and dispersal of complete and accurate agricultural data help to bring efficiency and cohesion to the total agricultural effort. This effort is not confined to the farmers themselves but also involves consumers, trade, and industry. The countries in these groups also experience varying degrees of governmental control which cannot be effective without accurate and timely data. Since speedy and repetitive data collection over large areas is a characteristic inherent in remote sensing systems, these systems will probably have a role to play in future agricultural data collection in these countries. Remote sensing will not do away with the necessity for the large variety of economic data now collected, but it should improve crop area, production, and yield data collection and make these tasks less cumbersome.

Good land use data and maps were found to be lacking in most of the 34 countries. Land use data are frequently byproducts of other efforts, such as the collection of agricultural data. The result is that large areas of lands outside those devoted to agriculture are frequently unaccounted for. The cost in money, time, and effort to collect data and to map land use--plus the lack of recognition of the importance of this information--has, in most countries, militated against such efforts. A few countries, such as the United Kingdom, the Netherlands, and Canada, have recognized the necessity and benefits to be derived from systematic land use data collection and mapping and have made resources available for this purpose. The Food and Agriculture Organization and the International Geographical Union have attempted to collect new data, organize existing data, and plan for future land use mapping on a world scale, but these efforts have made little progress.

The growing need for comprehensive land use data collection and mapping is directly related to the increasing human pressure on land resources. In the economically more advanced countries where most of the available agricultural lands have been occupied, it is becoming apparent that better land use information is needed. These countries want to know more fully the extent and location of their agriculturally productive lands as well as their forests, urban areas, transportation networks, recreation areas, and wastelands. They wish to know what changes in use are taking place. Growing populations are causing many countries to project their needs into the future and plan the use of land so that these populations will be provided for. The start of such planning involves accurate land use information depicting present conditions.

The developing countries also face the problems of growing populations, but their difficulties are more immediate than those of the economically advanced countries. Food production for the near future is the great problem in the developing countries. In the planning process to which these countries have turned as a first step on the way out of their common dilemma, land use mapping and data collection could provide the inventories that help distinguish between productive areas, areas with potential for future development, and wastelands.

The land use categories used by FAO in the annual Production Yearbooks include one called "Unused but Potentially Productive." In this category, FAO reports data provided by individual countries. It is significant that only 10 of the 34 countries in the sample reported land areas under this category to FAO in 1965. There is, admittedly, considerable confusion about

the meaning of the term "potentially productive." There is no uniformity here, and it is probable that some countries are reporting areas as being potentially productive which other countries would most certainly consider as wastelands. (The classification system of the I.G.U. avoids the identification of potentially productive areas altogether. Such areas are, no doubt, to be found under the following headings used in the I.G.U. classification. Unimproved grazing; Forest; Swamps and Marshes; and Unproductive.)

Remote sensing's contribution to the problem of distinguishing potentially productive lands could be to provide for land use maps accounting for the whole surfaces of countries and showing, at the least, the locations of unused or lightly used areas. The major problem would then be to sort out potential development areas from wastelands by means of research and mapping of soils, rainfall, slope, and other factors.

It seems likely that remote sensing systems will eventually provide much of the information for producing these land use maps. It is very likely also that remote sensors will be able to provide some of the needed information on soils, vegetation, and topography which will enable countries to further identify their potentially usable lands. Two conditions now account for existing gaps in land use information: Lack of recognition that such information is needed, and inability to pay the costs of getting the job done with traditional survey techniques. Even if all countries felt strongly about the need, the budget limitation would remain. Low cost techniques which will provide quick coverage of the earth's surface will enable presently felt, but unfilled, needs to be met. And the awareness of need may become more nearly unanimous as lower costs bring such data within reach of the more limited national budgets.

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